Depolarization anisotropy of radiation scattered by soil and vegetation in the visible

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The land surface is a paramount constituent of the Earth climate system. Its interactions with incoming solar radiation have a substantial impact on the Earth's energy budget. As it is known, the interaction of polarized radiation with the land surface is characterized by high depolarization of the output radiation. Very often the depolarization depends on the polarization of the incoming radiation. This effect is known as anisotropic depolarization.

We measured the Mueller matrices for some typical examples of land surfaces: soil (an upper clay-enriched subsoil of alfisols formed typically under a hardwood forest cover in semiarid to humid areas), moss Eurhynchium hians. Both samples of soil and moss are from the Goloseevo Forest near Kiev, Ukraine, May 2019), sand (sifted river sand with average dimension of grain approximately 50 μm), and white clay (industrially produced kaolin) at a wavelength of 632.8 nm. In this experiment the incoming laser beam was widened to 30-mm diameter to exclude the influence of samples surface local inhomogeneity on radiation scatter. The error of the Mueller matrix measurements is about 3%.

After measuring the sample's Mueller matrices we calculated all existed to date depolarization metrics and determined the depolarization matrices that are included in all currently known Mueller matrix decompositions. The obtained results show that depolarization in a complex way depends on the input polarization and has a completely individual character for each of the studied samples, which can certainly be used to identify them. This is illustrated by the dependences of output polarization degree on the azimuth and ellipticity of the input polarizations. The depolarization anisotropy significantly depends on the angle of observation. Interestingly, soil and moss are characterized by the greatest anisotropy of depolarization. In addition, all samples "forget" the input polarization much more efficiently than they "remember". In other words, the set of input polarizations, for which the output radiation has a minimum degree of polarization, is much more extensive than those of input polarizations, for which the output light has the maximum degree of polarization.

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